MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2015/2016

EEL3156 – RENEWABLE ENERGY TECHNOLOGY

(LE)

12 MARCH 2016
2:30 PM – 4:30 PM
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 6 pages with 5 Questions only.

2. Attempt **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

Question 1

(a) What is pumped storage plant and explain its working principle. [4 marks]

(b) Name two types of hydro turbines based on the nature of watering on the blades. [2 marks]

(c) A single jet Pelton wheel is built with the wheel radius of 4.5 m.The shape number of the turbine, ζ is 0.1. If the angular speed of turbine is 1.15 rad/s, find

(i) jet speed, [2 marks]
(ii) available head, and [2 marks]
(iii) develop power. [2 marks]

Question 2

(a) Name two types of wind turbines. [2 marks]

(b) A wind energy is to be harnessed in a specific area with a propeller turbine. The cross-sectional area of the turbine disc is 80 m^2. The air density is 1.0 kgm^{-3} and the wind speed is 10 ms^{-1}. If the interference factor is 0.15, calculate

(i) maximum thrust available to the turbine, [4 marks]
(ii) power in the wind, [2 marks]
(iii) turbine speed, and [2 marks]
(iv) power extracted by the turbine. [2 marks]

Continued .....

Question 3

(a) State and briefly explain the two types of solar energy systems used for heating air and water.

[4 marks]

(b) Figure Q3(b) shows a solar water heater system. The flat plate solar collector has a loss resistance $R_L = 0.1\ \text{m}^2\text{kW}^{-1}$ and a plate transfer efficiency $n_{pf} = 0.8$. The glass cover has transmittance $\tau = 0.9$ and the absorptance of the plate $\alpha = 0.85$. The ambient temperature $T_a = 25^\circ C$ and the irradiance in the plane of the collector $G = 720\ \text{Wm}^{-2}$. By assuming the plate temperature $T_p = 40^\circ C$, compute the following.

(i) The collector efficiency η_c. [6 marks]

(ii) The useful output power from the collector P_u. [2 marks]

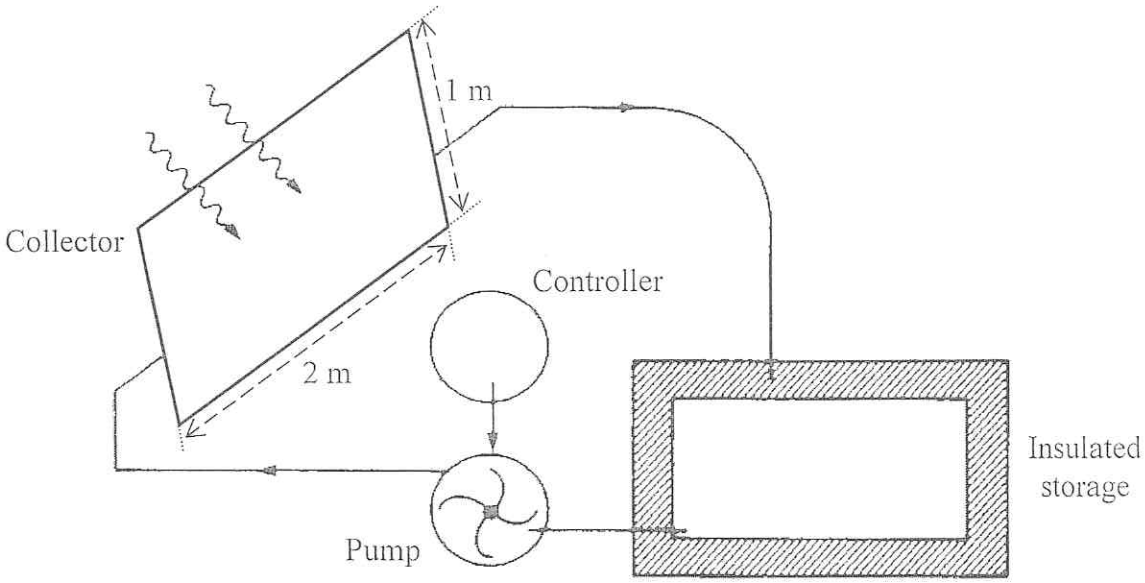

Figure Q3(b)

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Question 4

(a) Give three classifications of biomass energy.

[3 marks]

(b) In a hot aquifer system shown in Figure Q4(b), the aquifer thickness is 0.5 km, depth is 3 km, porosity is 5%, undersediments of density is $2700\ \text{kg m}^{-3}$, specific heat capacity is $840\ \text{J kg}^{-1}\text{K}^{-1}$ and temperature gradient is $30^{\circ}\text{C km}^{-1}$. If the time constant is 2.8×10^{9} s, calculate

(i) initial temperature T_2, [1mark]
(ii) useful heat per square kilometer above 40°C, [4 marks]
(iii) thermal power can be extracted at the beginning, and [2 marks]
(iv) thermal power can be extracted after 10 years. [2 marks]
(Assume 1 year is 365 days)

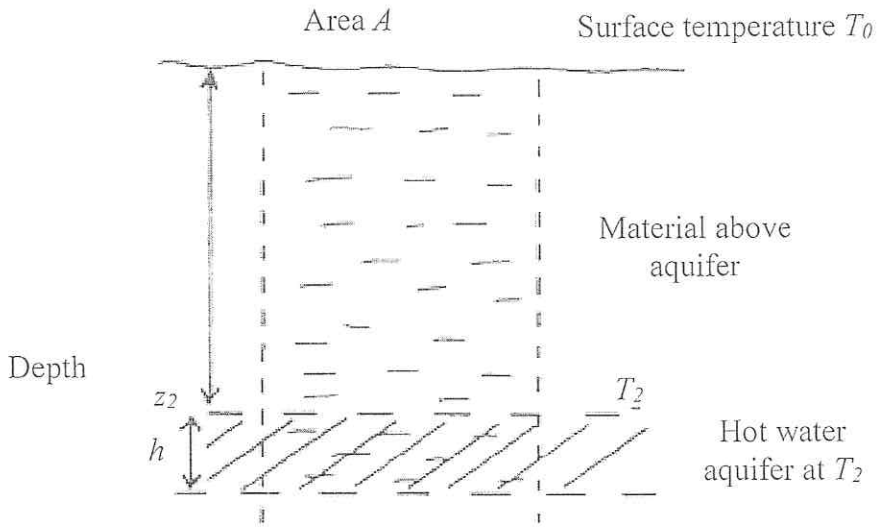

Figure Q4(b)

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Question 5

(a) Discuss the main challenges to integrate renewable energy sources into the utility grid and suggest one solution for each challenge.

[6 marks]

(b) Explain any three methods of energy storage employed in renewable energy system and give one example for each.

[6 marks]

End of Page

Appendix: List of equations and standard constants

$$P_0 = \rho Q g H_a$$

$$H_a = H_t - H_f$$

$$\frac{u_c}{u_j} = 0.5$$

$$P_j = \frac{1}{2}\rho Q_j u_j^{\ 2}$$

$$u_j^{\ 2} = 2gH_a$$

$$P_m = \frac{1}{2}\rho Q u_j^{\ 2}\eta$$

$$P_m = \eta P_j$$

$$R = \frac{(2gH_a)^{1/2}}{2\omega}$$

$$\zeta = \frac{\sqrt{P_m}\,\omega}{\sqrt{\rho}(gH_a)^{5/4}}$$

$$P_0 = \frac{1}{2}\rho A u_0^{\ 3}$$

$$\Gamma_{\max} = \frac{1}{2}\rho A u_0^{\ 2} R$$

$$\Gamma_{\max} = F_{\max} R$$

$$u_1 = (1-a)u_0$$

$$P_T = C_P P_0$$

$$C_P = 4a(1-a)^2$$

$$P_u = \eta_c A G$$

$$\eta_c = \eta_{sp}\eta_{pf}$$

$$\eta_{sp} = \tau\alpha - \frac{U_L(T_p - T_a)}{G}$$

$$U_L = \frac{1}{R_L A}$$

$$I = I_L - I_0[e^{\frac{q(V+IR_S)}{nkT}} - 1] - \frac{V + IR_S}{R_{sh}}$$

$$T_2 = T_0 + \frac{dT}{dz}z = T_0 + Gz$$

$$\frac{E_0}{A} = C_a\left(T_2 - T_1\right)$$

$$C_a = \left[p'\rho_w c_w + (1-p')\rho_r c_r\right]h$$

$$E_0 = \rho_r A c_r (z_2 - z_1)\frac{(T_2 - T_1)}{2}$$

$$\frac{dE}{dt} = \frac{E_0}{\tau}e^{-t/\tau}$$

Water density, $\rho = 1000\,\text{kgm}^{-3}$

Water thermal capacity, $c_w = 4200\ \text{Jkg}^{-1}\text{K}^{-1}$

Gravity acceleration, $g = 9.8\,\text{ms}^{-2}$

End of Appendix